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ABSTRACT

Guidance for the development, assessment and/or improvement of science education programs in Michigan is provided in this handbook for teachers, administrators, and parents. It provides a philosophical foundation and curricular framework from which educators could construct comprehensive local science education programs. The nature of science is defined and described in terms of its relationship with society, the learner, and the school curriculum. Suggestions are offered on how to implement a philosphy which aims for the development of the science and technology literacy of all citizens. Goals and objectives are identified and divided into seven major sections. These include: (1) life science; (2) physical science; (3) earth/space science; (4) science process; (5) science, technology, and society; (6) science attitudes; and (7) nature of science. Each of these discipline areas is further distributed into general topics and subtopics. Coverage expected at the K-3, 4-6, 7-9, and 10-12 grade levels is given for each subtopic and the topics are keyed as introductory, developmental, or reinforcement. Appendices include listings of supplementary resources, journals and newsletters, references, and acknowledgments. (ML)

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Essential Performance Objectives for Science Education

• GRADES K-9

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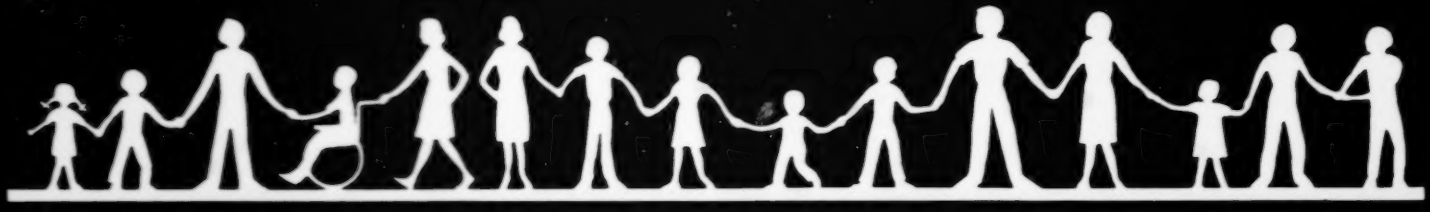

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FOREWORD

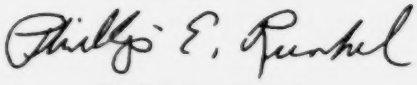
As the growth in scientific knowledge accelerates, change in all aspects of people's lives occurs more rapidly. The laser, the micro chip, personal computers, robotics, genetic engineering, and other media and engineering breakthroughs have changed for all time the way people do business, the way people communicate, the way people manufacture products, and the way people interrelate with other countries and societies. Indeed, the economy today is increasingly dependent upon scientific and technological advances.

Schools need to help students understand how science, technology, and society influence one another, and help them use this knowledge in making decisions as responsible citizens. Students need to have a substantial grasp of science including its content, processes, limitations, application, and societal implications. This will help them to learn to think rationally during and beyond the years of formal schooling.

The essential goals and objectives in this handbook provide direction for a comprehensive approach to science education in Michigan. It should be helpful to teachers, school administrators, and parents who are concerned with developing, assessing, or improving science education programs.

School staffs are encouraged to use this handbook as they develop science education programs to help students face the future with the tools they will need to build a better tomorrow.

Sincerely,



Phillip E. Runkel
Superintendent of
Public Instruction

October, 1985

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STATEMENT OF PURPOSE

These essential goals and objectives are designed to assist administrators and teachers in planning, developing, and implementing K-9 science programs and to provide some guidelines for 10-12 instruction. It provides a philosophical foundation and curricular framework from which educators may construct comprehensive local science education programs. The materials presented should aid local school systems in:

— Planning Curricula
— Developing a Philosophy
— Defining a Set of Goals for Science Education
— Developing a Scope and Sequence
— Evaluating the Extent that the Goals and Subgoals are Contained in Current Curricular Offerings
— Identifying Needed Curricular Content and Instructional Strategies

This document is organized into the following major sections:

— **Philosophy** — defines the nature of science and describes its relationship with society, the learner, and the school curriculum.

— **Goals** — are broad statements of desired outcomes which are derived from the philosophy and bring direction to the program. They are organized into seven major areas that are listed below:

LIFE SCIENCE
PHYSICAL SCIENCE
EARTH/SPACE SCIENCE
SCIENCE PROCESS
SCIENCE, TECHNOLOGY, & SOCIETY
SCIENCE ATTITUDES
NATURE OF SCIENCE

— **Appendix** — has additional information about available materials and organizations that may be of interest to science curriculum committees.

PHILOSOPHY

The central purpose of science education is to develop the scientific and technological literacy of all citizens. The level of literacy is influenced by the changing needs and demands of society; therefore, this goal is dynamic rather than static. To meet this goal, science educators must assume responsibility for meeting the science education needs of **all** persons, not only those who become scientists, engineers, or professionals in a science-related field. (Berkheimer 1984)

Science is a way of knowing the universe, of which we are a part. It involvers **process skills,** such as observing, classifying, hypothesizing, inferring, and communicating as well as **problem solving skills** using one's rational powers and fostering their development through logical and imaginative thinking. Science is also a way to **organize knowledge** in the form of concepts and content. It involves the development of an attitude of inquiring as well as an attitude of understanding including aspirations affecting the individual and society. (NSTA 1982)

Modern technology uses knowledge generated by science to change the human environment. Technology is the art of making practical use of science knowledge. "Science describes the world as it is; technology makes the world to serve a human desire . . . Technology serves as a bridge between science and society, unifies the various disciplines." Science interacts with society through technology. (Hurd 1975)

The influence of science and technology on society is obvious. And, although the influence of society on science and technology is less obvious, society influences science and technology in numerous ways. For example, public funds are the single largest source of support for science and technology (Rosings, Speigal, and Derek 1977); representatives of the people — federal and state legislators — continuously make value judgements concerning the kinds of science and technology that will or will not receive support.

The average citizen through his/her consumer choices, by voting for elected officials, communicating to decision makers, and supporting organizations greatly influences the direction of science and technology. (Berkheimer 1984)

The preparation of scientifically literate students, which is needed for responsible citizenship, is largely determined by the science program which they study in grades K-12.

IMPLEMENTATION OF PHILOSOPHY

To move toward implementation of this philosophy, the Michigan Board of Education's recommendation in **Better Education For Michigan Citizens: A Blue Print For Action** is that local boards of education require all students to complete two years of science including both biological and physical science as a high school graduation requirement. Three years of science are recommended for college-bound students including biology, chemistry, and physics.

To accomplish this, both the overall science curriculum and specific courses within that curriculum need to be considered as a program is developed. A description of an overall science curriculum and suggestions for programs within that curriculum follow.

PLANNING A SCIENCE CURRICULUM

Science programs meet the basic scientific literacy needs of all students when appropriate emphasis is placed on four major goal clusters: (Harms 1981)

1. **Personal Needs** that prepare individuals to utilize science for improving their lives and for coping with an increasingly technological world.

2. **Societal Issues** that produce informed citizens prepared to deal responsibly with science-related social problems.

3. **Academic Preparation** that allows students who are likely to pursue science academically as well as professionally to acquire knowledge appropriate to their needs.

4. **Career Education/Awareness** that gives all students an awareness of the nature and scope of a wide variety of science and technology-related careers open to students of varying aptitudes and interests.

The science curriculum is based on a continuum of fundamental concepts and skills from kindergarten through grade 12. A balanced curriculum is offered through the study of the three major content areas of science — biological, physical, and earth-space. Students also become proficient in use of science process skills, and understand the interrelationships of science, technology, and society.

Students gain a greater understanding of the fundamental concepts and become more proficient in the skills of science as they progress from the lower to the upper grades. Concepts and process skills serve as the basic framework for the science program, grades K-12.

The child's first experience with science, from the earliest grades, should involve aspects of experimental inquiry. Use is made of all the senses in developing such skills as observing, measuring, classifying, using numbers, and communicating. Three important aspects of science — process (doing), content (knowledge), and attitude (feelings) — are kept in the forefront during all phases of planning and instruction. The three cannot be totally separated. To help assure success, learning experiences must be presented at the appropriate developmental level for each student. In this way, the end product is rewarding and provides each student with a sense of accomplishment. Laboratory and field work are very important to the teaching of science at all levels. The activities provide ways for making science more understandable and meaningful.

Current science and technology provide many opportunities for a student to select and prepare for a science or science-related occupation. A well-balanced science curriculum provides students with an awareness of educational and career opportunities available through (1) study of the historical development of science, (2) study of science/technological advances, (3) use of non-school resource persons, (4) field trips, and (5) on-site studies. Such activities enhance self-development attitudes toward work, decision making, and appreciation of various life styles. (North Carolina 1985)

An overview of the major emphasis at K-3, 4-6, 7-9 follows:

PRIMARY/CHILDHOOD (K-3)
Emphasis at this level is placed on providing manipulative "hands on" experiences for each child. Such experiences provide opportunity for the use and development of science skills and lead gradually to the understanding of basic science and environmental concepts. Coming in contact with and interacting with objects and observing events is most important. With these children, process is more important than a correct answer or a finished product. A balanced program is provided by placing emphasis on the concepts related to each of the broad areas of science — biological, physical, and earth-space. In selecting and planning experiences, careful attention must be given to the physical and intellectual development of each child. Science at this level should always be a fun and "doing" experience.

INTERMEDIATE GRADES (4-6)
There is a continuation of the utilization of skills and the development of major science concepts that were begun at the primary level. The program provides a sound base for future study. Balanced coverage is given to the broad areas of science — living things, matter and energy, and earth space. Opportunity is provided for students to begin using scientific apparatus and audio-visual materials of a more sophisticated nature. Individual and small group exploratory activities are appropriate at this level. Greater use is made of outdoor resources and non-school resource personnel as a means for making the study of science more relevant to the student's own environment.

MIDDLE SCHOOL/JUNIOR HIGH (7-9)
The middle grades/junior high science curriculum is characterized by specialization into life science, earth science, and physical science, with environmental concept woven in at all three levels. The student, for the first time, is introduced to an in-depth, year-long study of one major area of science. Student involvement in the courses is stressed as they participate in problem solving, collecting data, and drawing conclusions. Students are able to manipulate apparatus and to conduct scientific investigations with increased sophistication. A higher degree of understanding of the fundamental concepts of science and proficiency in the skills of science are attained by the students. (North Carolina 1985)

Introduction of Essential Goals and Objectives

These goals and objectives are divided into six (6) major sections: Science Content in Life; Physical and Earth-Space Science; Processes; Science Technology and Society; Science Attitudes; and the Nature of Science. The first section provides statements describing basic understandings students are expected to acquire in the Life Sciences, Physical Sciences and Earth Sciences. These understandings are meant to include not only knowledge of the topic, but higher levels of thinking as described by Bloom's Taxonomy. Students, as they proceed through the grade levels, should be able to demonstrate their ability to apply what they have learned in new situations, to analyze, synthesize and evaluate information about the topic. Additional goals include attitudes toward science and science technology and societal issues. Each of these disciplinary areas is further distributed into general topics and sub-topics. Coverage expected at K-3, 4-6, 7-9 and 10-12 grade levels is given for each sub-topic and topics are listed as introductory, developmental or reinforcement. These terms are defined as follows:

> The **Introductory** level is the initial formal contact of a student with the topic. The topic is named, identified, defined and illustrated with examples from the student's experience.
>
> The **Developmental** level of a topic includes further examples and additional instances of the phenomena, object or event under study. Concepts are enlarged with additional details, measurements or properties and comparisons.
>
> **Reinforcement** includes real life applications of the topic and the addition of mathematical models to the explanations. Some examples relate to the societal and personal impacts of the content area.

Processes

The second section provides statements describing basic process skills that students are expected to acquire in a well-balanced science program. The ability to process and use information depends not only on selecting the appropriate form of knowledge but also upon certain cognitive abilities, namely, problem solving, decision making and logical reasoning.

These processes include:

Observing
Inferring
Measuring
Classifying
Predicting
Using Space/Time Relations
Communicating
Operational Definitions
Identifying and Controlling Variables
Gathering and Interpreting Data
Constructing Testable Hypotheses
Testing Hypotheses

These processes are actually labels for collections of productive intellectual behaviors or skills. And these intellectual skills describe what individuals can do rather than what individuals can verbalize.

How the attributes of thinking, problem solving, and decision making are combined and applied depends on the nature of the problem and the available information.

Science Technology and Society

The third section provides statements describing the nature of science technology and society.

Development in science and technology cannot be considered in isolation from their social context. Science and technology are, in fact, social issues — issues that require intelligent decision making in the social policy arena. In an age in which scientific knowledge and technological development are increasing exponentially, effort must be expended to ensure that young people acquire not only scientific and technological literacy, but also the skills necessary to analyze problems and issues and make informed judgements.

Attitudes

The fourth section provides statements describing attitudes.

It is our sense of what is important that leads us to pay attention to a stimulus, to study it in detail, and to seek more stimuli to help us learn. Attitudes are manifestations of our values that have become part of habitual behavior patterns. We tend to react in the same or similar way to whole classes of stimuli, thus reflecting our attitude towards this class.

The goals and objectives about attitudes together with their amplifying statements are meant to present a clear picture of what is significant in the affective area of the K-9 science curriculum. The goals and objectives in this document are based on those presented by the Educational Policies Commission (EPC).

Nature of Science

The fifth section provides statements describing the nature of science.

Currently the scientific enterprises can be thought as having two major components: scientific knowledge and scientific inquiry. Scientific knowledge represents, at a given time, the laws, principles, theories, concepts, and data bases which the scientific community recognizes as being the most accurate and useful.

Scientific inquiry is made up of the procedures used to generate scientific knowledge and is grounded in sound, cognitive, manipulative, and investigative processes.

Summary

The updated rationale, philosophy, and essential goals and objectives contained in this document are designed to assist administrators and teachers in planning, developing, and implementing K-9 science programs. It is anticipated that local plans will vary, depending on local philosophy, needs, and tradition.

This document should be helpful to all districts as they review their current science program and plan future programs.

SCIENCE CONTENT CATEGORIES

I. Life Science

A. Systematic: Diversity of Organisms

B. Cellular and Molecular Biology

C. Energy Transformation (photosynthesis & respiration)

D. Heredity

E. Growth and Development

F. Systems (structure and function of organisms)

G. Evolution

H. Ecology

I. Behavior

I. LIFE SCIENCE

A. Systematics: Diversity of Organisms

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. differences exist between living and non-living things	ID*	R*	R*	R*
2. there are many kinds of living things	I	D*	R*	R*
3. living things exhibit basic similarities and the classification of these organisms is based on their similarities and differences	ID*	R*	R*	R*
4. living things may be grouped and classified from the simplest to the most complex	I	D*	R*	R*
5. the levels of complexity within living organisms (cells, tissues, organs and systems)		I	DR*	R*
6. the wide variation within human species	I	D*	R*	R*
7. special tools are used to extend our senses to study and classify organisms (handling, microscopes, balances, etc.)	I	D*	R*	R*

B. Cellular and Molecular Biology

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:

1. the basic unit of life is the cell		I	D*	R*
2. many simple living things are composed of one cell		I	D*	R*
3. differences between typical plant and animal cells		I	D*	R*
4. the parts of cells		I	D*	R*
5. the major chemicals that form cells			I	D*
6. the cell processes including respiration, protein synthesis, photosynthesis, reproduction			ID*	R*
7. methods of transportation of cellular materials			ID*	R*
8. radio active elements are used to trace some elements in cells		I	D*	R*

I = Introduce
D = Develop
R = Reinforce
* = Level Tested

C. Energy Transformation (photosynthesis and respiration)

	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. living things use food for energy (respiration)	I	D*	R*	R*
2. green plants have the ability to make their own food (photosynthesis)	ID*	R*	R*	
3. living things require energy and there must be an interchange of energy in a balanced environment if living things are to survive		I	D*	R*
4. photosynthesis depends on factors such as light energy, chlorophyll, water, and carbon dioxide		I	D*	R*
5. there are differences between photosynthesis and respiration		I	D*	R*
6. the processes by which organisms capture, utilize, and release energy		I	D*	R*
7. respiration (aerobic and anaerobic)			ID*	R*
8. chemosynthesis is an alternative method that some living things use to produce their own food			I	D*
9. some plants do not have the ability to make their own food (fungi)		I	D*	R*

D. Heredity

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. offspring resemble their parents	ID*	R*	R*	R*
2. living things are a product of heredity and environment	I	D*	R*	R*
3. living things reproduce and transmit traits		I	D*	R*
4. a pattern of inheritance can be observed over a period of time		I	D*	R*
5. there are wide variations within humans (eye color, hair color, fingerprints)			ID*	R
6. Mendel's laws of inheritance			ID*	R

I = Introduce
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D. Heredity (Continued)	K-3	4-6	7-9	10-12
7. a change in a gene that results in a new trait is called a mutation		I	D*	R*
8. chemical nature of genes and chromosomes and their role in maintaining genetic continuity			I	D*
9. closing and genetic engineering could create social problems			I	D*
E. Growth and Development				
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. living things have basic needs (food, H_2O, temperature range, etc.)	ID*	R*	R*	R*
2. plants and animals go through a series of changes as part of their individual life cycle	ID*	R*	R*	R*
3. living things change throughout their lives (growth — changes in size, development, change in structure and function)	I	D*	R*	R*
4. human beings exhibit a period of growth from infancy to adult		I	DR*	R*
5. there are wide variations within what is termed "normal" in organisms		I	D*	R*
6. the relationship between heredity and nutrition in growth and maturation in organisms		I	D*	R*
F. Systems (structure and function of organism-protists-plants-animals)				
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. living things have adaptations which enable them to survive	I	DR*	R*	R*
2. the human body is composed of various systems with specific structures and functions	I	D*	R*	R*
3. plants and animals have complex systems to carry out basic functions		ID*	R*	R*
4. organ transplants could cause societal problems		I	D*	R*

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G. Evolution

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:	K-3	4-6	7-9	10-12
1. living things change through time	I	D*	R*	R*
2. the environment is always changing and living things must be able to adjust to these changes in order to survive	I	D*	R*	R*
3. some plants and animals have become extinct	I	D*	R*	R*
4. fossil evidence provides indirect evidence that many forms of life have become extinct		I	D*	R*
5. natural selection is the mechanism by which changes occur in populations		I	D*	R*
6. evolution is a theory in the sense that theories are a basic part of the process of science (see the Nature of Science)			ID*	R*

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H. Ecology

	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. living things are interdependent and are constantly interacting	I	D*	R*	R*
2. simple food chains	ID*	R*	R*	R*
3. essential role of plants to all living things	ID*	R*	R*	R*
4. living things and their environments are interdependent and are constantly interacting	I	D*	R*	R*
5. relationship between food chains and a food web	I	D*	R*	R*
6. the relationship among producers, consumers, and decomposers		ID*	R*	R*
7. ecological relationships among organisms (populations, communities, ecosystems, biomes, habitats)		ID*	R*	R*
8. flow of energy through natural systems		I	D*	R*
9. the dynamics of ecology is essential for intelligent planning and decision making		I	D*	R*
10. the environment of a living thing includes both living and nonliving factors	I	D*	R*	R*
11. the basic cycles that occur in an ecosystem			ID*	R*
12. air and water pollution affect living things		I	D*	R*

I. Behavior

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. living things receive and respond to stimuli	I	D*	R*	R*
2. systems within a living thing enable it to respond to stimuli from the environment		I	D*	R*
3. behavioral responses help a living thing survive and reproduce		I	D*	R*
4. distinguish between anthropomorphic explanations and scientific explanations of behavior			ID*	R*

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SCIENCE CONTENT CATEGORIES

II. Physical Science

A. Mechanics (motion, force, principles of conservation)

B. Waves/Light Optics

C. Electricity and Magnetism

D. Modern Physics, Atomic-Nuclear-Relativity

E. Heat and Kinetic Energy

F. Chemical Matters: Structure of Matter

G. Chemical: Periodic Classification

H. Chemistry: States of Matter and Nature of Solution

I. Chemistry: Chemical Reactions to Matter

II. PHYSICAL SCIENCE

A. Physics: Mechanics (motion, force, principles of conservation)

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:	K-3	4-6	7-9	10-12
1. a force is a push or a pull	I	D*	R*	R*
2. a force has both magnitude and direction		I	D*	R*
3. work is done when a force is exerted through a distance		I	D*	R*
4. power is the rate at which work is done		I	D*	R*
5. simple machines change the force or direction required to do work	I	D*	R*	R*
6. all machines are derived from simple machines		I	D*	R
7. friction and gravity are forces which act on objects	I	D*	R*	R*
8. pressure applied on a confined fluid is transmitted equally and in every direction			I	DR*
9. the motion of an object can be described by its velocity and/or acceleration			I	DR*
10. energy exists in various forms which may be changed from one form to another		I	D*	R
11. there are useful applications of mechanical energy (tools, complex machines, transportation, manufacturing, etc.)	I	D	R*	R*

I = Introduce
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B. Physics: Waves/Light Optics

	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. the nature and production of sound	I	D*	R*	R*
2. sound is a form of energy	I	D*	R*	R*
3. the characteristics of sound	I	D*	R*	R*
4. the effects of sound (music, ultrasound, applications, noise pollution, etc.)	I	D*	R*	R*
5. light is a form of energy	I	D*	R*	R*
6. the nature and sources of light		I	D*	R*
7. the characteristics of light		I	D*	R*
8. the effects of light (vision, color, spectroscopy, etc.)		I	D*	R*
9. energy can be transmitted by means of wave motion			I	DR*
10. the relationship of wave energy to other forms of energy		I	D*	R*
11. light exhibits both wave and particle properties		I	D*	R*
12. the relationship between color, wave length, and the electromagnetic spectrum		I	D*	R*
13. the useful applications of wave energy (optical devices, lasers, sound amplifications, recording, radio and sound transmission and reception, solar cells, musical instruments, etc.)	I	D*	R*	R*

C. Physics: Electricity and Magnetism

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. the nature of magnetism and magnetic force	I	D	R*	R*
2. the theories of magnetism			I	DR*
3. static electricity	I	D*	R*	R*
4. conductivity		I	D*	R*

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C. Physics: Electricity and Magnetism (Continued)

	K-3	4-6	7-9	10-12
5. electrical circuits		I	D*	R*
6. the relationship between magnetism and electricity		I	D*	R*
7. electrical production and usage		I	D*	R*
8. electrical power		I	D*	R*
9. the relationship between electricity and other forms of energy		I	D*	R*
10. the relationship between electricity and chemical change			I	DR*
11. the useful application of electricity and magnetism (telemetry, radar, inertial navigation and satellite navigation, motors, telephones, electronics, etc.)	I	D*	R*	R*

D. Physics: Modern Physics, Atomic, Nuclear, Relativity

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:

1. nuclear structure of matter			I	DR*
2. the law of conservation of matter and energy			I	DR*
3. radioactivity			I	DR*
4. nuclear fission			I	DR*
5. nuclear fusion			I	DR*
6. the relationship of nuclear energy to other forms of energy		I	D*	R
7. simple ideas of relativity		I	D*	R*
8. useful applications of radioactivity (medicine, electrical energy, x-rays, PET scanner, etc.)		I	D*	R*

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R = Reinforce
* = Level Tested

E. Energy: Heat and Kinetic Energy	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. the definition of energy		I	D*	R*
2. energy exists in several forms	I	D*	R*	R*
3. the uses of energy	I	D*	R*	R*
4. primary and secondary sources of energy	I	D*	R*	R*
5. energy can be measured	I	D*	R*	R*
6. potential and kinetic energy		I	D*	R*
7. interactions of matter and energy		I	D*	R*
8. molecular theory of heat			I	DR*
9. distinction between heat and temperature			I	DR*
10. the law of conservation of matter and energy			I	DR*
11. heat transfer	I	D*	R*	R*
12. the relationship of heat energy to other forms of energy	I	D*	R*	R*
13. the useful applications of heat and kinetic energy (microwave oven, home heating and cooking, refrigeration, heat pump, etc.)	I	D*	R*	R*

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F. Chemical Matter: Structure of Matter

	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. measurement of mass, length, volume	I	D*	R*	R*
2. materials can be described by their properties	I	D*	R*	R*
3. materials can be classified by their properties	I	D*	R*	R*
4. some of the properties of matter are measurable	I	D*	R*	R*
5. objects can be ordered serially in terms of their properties	I	D*	R*	R*
6. useful applications of physical properties of matter (commercial measurements of mass, volume, and length)		I	D*	R*
7. the common elements			I	DR*
8. the atomic structure of matter			I	DR*
9. the structure of matter			I	DR*
10. crystals		I	D*	DR
11. the nature of freezing, melting, condensing, boiling, and evaporation	I	D*	DR*	R*
12. the properties of acids, bases, and salts		I	D*	DR

G. Chemical: Periodic Classification

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. the general atomic structure of matter		I	D*	R*
2. the periodic chart of elements			I	DR*
3. chemical properties of an element are a function of electron configuration			I	DR*
4. the chemical activity of an element depends on its ability to gain or share electrons			I	DR*
5. isotopes			I	DR*
6. like all theories, atomic theory is subject to change			I	DR*

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H. Chemistry: States of Matter and Nature of Solutions The Learner Will Gain:

	K-3	4-6	7-9	10-12
Understandings of the following general content objectives through selected activities that are consistent with student intellectual level:				
1. states of matter, particularly solids, liquids, and gases	I	D*	R*	R*
2. the states of matter have different properties	I	D*	R*	R*
3. the state of matter can be changed	I	D*	R*	R*
4. energy interacts with matter to produce changes	I	D*	R*	R*
5. physical and chemical changes		I	D*	R*
6. some materials dissolve	I	D*	R*	R*
7. mixtures and compounds		I	D*	R
8. chemical compounds are classified according to their properties			ID*	R*
9. solutions			ID*	R*
10. suspensions and colloids			ID*	R*
11. saturated and non-saturated solutions		I	D*	R*
12. ions			I	DR*
13. crystals and crystallization		I	D*	R*
14. the difference between organic and inorganic compounds			ID*	R*
15. the useful applications of crystallization (microchips, quartz watches)				DR*
16. the useful applications of elements, compounds and mixtures (medicine, industry, home)	I	D*	R*	R*

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I. Chemistry: Chemical Reactions of Matter (chemical transformations)

	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. all matter consists of elements		I	D*	R*
2. elements have particular properties		I	D*	R*
3. compounds consist of two or more chemically combined elements		I	D*	R*
4. compounds have particular properties			ID*	R*
5. mixtures are two or more substances that are not chemically combined		I	D*	R*
6. differences between elements, compounds, and mixtures			ID*	R*
7. chemical symbols, formulas, and equations			ID*	R*
8. useful applications of matter's chemical properties (pyrex glass, water softeners, combustion engines, fertilizers, etc.)		I	D*	R*
9. the useful applications of chemical changes (fuel cells, batteries, electroplating, etc.)		I	D*	R*

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SCIENCE CONTENT CATEGORIES

III. Earth and Space Science

A. Meteorology: The Earth, Atmosphere, and Weather

B. Materials of the Earth (rocks, minerals, water, natural resources)

C. Climate

D. Oceans

E. Earth's Crust (structure, evolution, history, change)

F. Space

G. Solar System, Galaxies, Universe

III. EARTH AND SPACE SCIENCE

A. Meterology: The Earth's Atmosphere and Weather

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:	K-3	4-6	7-9	10-12
1. atmosphere surrounds the earth	I	D*	R*	R*
2. composition and property of air	I	D*	R*	R*
3. sun is the major source of earth's energy	I	DR*	R*	R*
4. the sun's energy and geophysical processes	I	D*	R*	R*
5. air movement in the atmosphere		I	D*	R*
6. clouds and precipitation	I	D*	R*	R*
7. weather systems		I	D*	R*
8. weather forecasting		I	D*	R*
9. weather phenomena (tornadoes, floods, blizzards, hurricanes, and jet streams)		I	D*	R*
10. weather instruments (anemometer, barometer, hygrometer, rain gauge, sling psychrometer, and thermometer)		I	DR*	R*
11. useful applications of balloons, radar, and weather satellites		I	DR*	R*

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B. Materials of the Earth (rocks, minerals, water)

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:	K-3	4-6	7-9	10-12
1. earth is made of rock and minerals	I	D*	R*	R*
2. properties of rocks and minerals	I	D*	R*	R*
3. formation of igneous, sedimentary, metamorphic rocks		ID*	R*	R*
4. weathering of rocks and minerals		I	D*	R*
5. identification of rocks and minerals		I	D*	R*
6. soil formation	I	D*	R*	R*
7. how gravitational forces move weathered material to sea level		I	D*	R*
8. the hydrologic cycle		I	D*	R*
9. the earth's crust and various layers	I	D*	R*	R*
10. earth as a system in space with limited natural resources		I	D*	R*
11. disturbing environmental balance	I	D*	R*	R*
12. effects of technological improvements		I	D*	R*

C. Climate

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. four seasons in the United States	I	D*	R*	R*
2. why weather changes from season to season	I	D*	R*	R*
3. there are many kinds of weather, and it is always changing	I	D*	R*	R*
4. weather is the condition of the climate in a place at a given time		I*	D*	R*
5. physical factors that affect climate		I*	D*	R*

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D. Oceans

	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. ¾ of the earth's surface is covered by water		I	D*	R*
2. ocean basins are as varied as the continents (physographic features of the ocean basins)		I	D*	R*
3. properties and composition of ocean water		I	D*	R*
4. how water waves are generated		I	D*	R*
5. shorelines are changed by winds, tides, currents, waves, and tectonic action		I	D*	R*
6. the relationships between the earth, sun, and moon creates tides		I	D*	R*
7. the effects of ocean currents on land, and water, climate and ecosystems		I	D*	R*
8. the useful applications of diving bells, bathyspheres, and sonar and processes of obtaining fresh water from salt water		I	D*	R*

E. The Earth's Crust — Its Structure, Evolution, History and Platetonic Changes

The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. earth's surface is always changing	I	D*	R*	R*
2. the crust is composed of plates that move		I	D*	R*
3. earthquakes and volcanoes are found or occur at plate boundaries		I	D*	R*
4. forces changing the earth affect land formation and the formation of bodies of water (running water, glaciers)		I	D*	R*
5. landforms are the result of geologic pressure acting over long periods of time		I	D*	R*
6. general geologic history of the earth's crust		I	D*	R*
7. fossils give evidence of the kinds of plants and animals that once lived on earth		I	D*	R*
8. geologic and fossil records reflect a sequence of geological and biological events in earth histor			ID*	R*

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F. Space	K-3	4-6	7-9	10-12
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. achievements involved in space exploration and travel		I	D*	R*
2. basic principles on which rockets operate		I	D*	R*
3. certain physical principles control escape from earth into space		I	D*	R*
4. some benefits and applications obtained from the space program (minaturization, computers, navigational satellites, weather satellites, communication systems)		I	D*	R*
G. Solar System, Galaxies, Universe				
The learner will gain understandings of the following general content objectives through selected activities that are consistent with student's intellectual level:				
1. day and night are caused by the earth's rotation on its axis	I	D*	R*	R*
2. relationship between the earth and the moon	I	D*	R*	R*
3. phases of the moon		I	D*	R*
4. earth as a planet moving through space in the solar system	I	D*	R*	R*
5. the theoretical origins of the solar system and the universe		I	D*	R*
6. the major structures found in the universe including the sun and its planets	I	D*	R*	R*
7. the utilization of technology to explore objects or conditions in space (optical and radio telescopes, satellites, stectroscopes, etc., photographs, space probes, etc.)		I	D*	R*

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SCIENCE PROCESSES CATEGORIES

IV. Science Processes

A. Observing/Identifying

B. Classifying

C. Measuring

D. Sequence/Ordering

E. Inferring

F. Predicting

G. Communicating

H. Interpreting Data

I. Investigating

J. Controlling Variables

K. Formulating Hypotheses

L. Operational Definitions

M. Formulating Model

IV. SCIENCE PROCESSES

A. OBSERVING/IDENTIFYING:

Using one or more of the senses to determine attributes and properties of natural phenomena and objects. Observations can be made directly with the senses, or indirectly through the use of simple or complex instruments. Observations are influenced by the previous experiences of the observer.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. identify at least three properties of an object	ID*	R*	R*	R*
2. identify at least three properties of an object without using the sense of sight	ID*	R*	R*	R*
3. select the object which has a property to the greatest (or least) extent	ID*	R*	R*	R*
4. select a set which is numerically larger	ID*	R*	R*	R*
5. identify changes in an object	ID*	R*	R*	R*
6. identify one property of an object or organism that can be seen with a magnifying glass	ID*	R*	R*	R*
7. identify three or more parts of a system		ID*	R*	R*
8. identify objects which have a given characteristic		ID*	R*	R*
9. describe the motion of an objective relative to a reference point		ID*	R*	R*
10. identify unrelated elements in a system		ID*	R*	R*
11. construct a record of the conditions contributing to or resulting from contrived events or natural phenomena			ID*	R*
12. specify changes which take place during the progress of natural and artificial phenomena			ID*	R*
13. given an altered situation, select a resulting change			ID*	R*
14. identify measurable properties of living and nonliving things with conventional laboratory instruments			ID*	R*
15. compare initial and final states of physical systems under stress			ID*	R*
16. record the interactions among the components of natural systems and/or artificial systems			ID*	R*

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B. CLASSIFYING:

Sorting and grouping objects or events according to similarities and differences selected by the observer. Classification is based on observational relationships which exist between objects or events.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. select objects which have a specific property	ID*	R*	R*	R*
2. select objects having two specific properties	ID*	R*	R*	R*
3. sort objects into two groups on the basis of a specific property	ID*	R*	R*	R*
4. identify an object that does not belong in a set	ID*	R*	R*	R*
5. given two properties of several objects, sort into two sets on the basis of those two properties		ID*	R*	R*
6. identify a property by which two sets are distinguished		ID*	R*	R*
7. distinguish between useful and relevant data			ID*	R*
8. select a property and classify a set of objects into at least two subsets			ID*	R*
9. distinguish between objective and subjective information			ID*	R*
10. distinguish between fact and inference			ID*	R*

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C. MEASURING:

Developing quantitative descriptions of such properties as length, area, volume, weight, mass, temperature, and pressure. The process can involve the use of instruments and the skills needed to effectively use them.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. measure the length of an object in terms of a standard	ID*	R*	R*	R*
2. measure an object to the nearest centimeter	ID*	R*	R*	R*
3. measure the mass of an object to the nearest kilogram	ID*	R*	R*	R*
4. determine (estimate) whether a temperature is above or below another temperature	ID*	R*	R*	R*
5. determine the capacity of a container to the nearest liter	ID*	R*	R*	R*
6. determine the length of an object (or picture of an object) to the nearest centimeter		ID*	R*	R*
7. determine the volume of a container to the nearest milliliter		ID*	R*	R*
8. determine the mass of an object to the nearest gram		ID*	R*	R*
9. read and record a temperature to the nearest degree		ID*	R*	R*
10. use a reference unit of length to demonstrate the difference between two unknown lengths			ID*	R*
11. use a reference unit of length to demonstrate the difference between two unknown volumes			ID*	R*
12. construct simple instruments useful in determining length, mass, and volume			ID*	R*
13. use correctly the names of metric units			ID*	R*
14. identify appropriate standards for measuring various lengths			ID*	R*
15. assert the constancy of length when using different units to measure the length of an object			ID*	R*
16. distinguish between Celsius and Fahrenheit temperature scales			ID*	R*

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C. MEASURING: (Continued	K-3	4-6	7-9	10-12
17. observe and record time intervals associated with natural cycles and phenomena			ID*	R*
18. design simple instruments with which time intervals can be measured			ID*	R*

D. SEQUENCE/ORDERING:

Arranging objects, events, or ideas in a specific order.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

1. arrange (identify) objects from fewest to most	ID*	R*	R*	R*
2. arrange (identify) objects from largest to smallest	ID*	R*	R*	R*
3. arrange (identify) objects from longest to shortest	ID*	R*	R*	R*
4. arrange (identify) volumes from greatest to least	ID*	R*	R*	R*
5. arrange a set of objects of various masses in order from least mass to most mass without using a balance		ID*	R*	R*
6. arrange a mixed sequence of objects into a developmental sequence		ID*	R*	R*
7. arrange a set of objects in order according to their volume		ID*	R*	R*
8. order objects on linear, mass, and volume dimensions			ID*	R*
9. order physical events			ID*	R*
10. order biological events			ID*	R*

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E. INFERRING:

Providing explanations, reasons, or causes for events. Inferences are based on judgement and are not always valid.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. identify one cause for a change	ID*	R*	R*	R*
2. identify an inference based on an observation		ID*	R*	R*
3. identify an inference which utilizes a property of an object discernible by any combination of senses		ID*	R*	R*
4. identify or construct reasonable explanations of observations related to physical phenomena			ID*	R*
5. identify or construct reasonable explanations of observations related to biological phenomena			ID*	R*
6. list some observations required to test an inference			ID*	R*

F. PREDICTING:

Suggesting what will occur in the future based on observations, measurement and inferences about relationships between or among observed variables. Accuracy of a prediction is closely affected by the accuracy of the observation.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

1. make and confirm a prediction	ID*	R*	R*	R*
2. select an activity useful for testing a prediction	ID*	R*	R*	R*
3. predict the change which is most likely to occur in an object or system after several observations		ID*	R*	R*
4. identify a generalization or rule which summarizes the changes which occur in an object or system after several observations		ID*	R*	R*
5. interpolate from data which reveal patterns			ID*	R*
6. extrapolate from graphs or data			ID*	R*
7. identify or design tests for predictions made from experimental data			ID*	R*
8. identify or construct revisions of predictions based on additional information			ID*	R*

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G. COMMUNICATING:

Using the written and spoken word, graphs, and diagrams as a means of transmitting information and ideas to others. Such skills as asking questions, discussing, explaining, reporting, and outlining can aid the development of communication skills.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. read a bar graph	ID*	R*	R*	R*
2. construct a bar graph	ID*	R*	R*	R*
3. read a table of recorded observations	ID*	R*	R*	R*
4. describe a science experience	ID*	R*	R*	R*
5. explain the function of a specified part in a system		ID*	R*	R*
6. construct a graph to represent a relationship between two variables		ID*	R*	R*
7. report the following information in writing:				
a. statement of the problem				
b. materials used in the investigation				
c. procedure used in the investigation				
d. results of the investigation				
e. conclusion(s) of the investigation		ID*	R*	R*
8. describe the characteristics which a group of objects, living things, or a set of natural phenomena have in common			ID*	R*
9. describe characteristics which illustrate differences among a group of objects, living things or a set of natural phenomena			ID*	R*
10. construct bar and line graphs of investigative data, portraying conditions and trends revealed by the data			ID*	R*
11. make drawings or diagrams to convey information collected during an investigation			ID*	R*

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H. INTERPRETING DATA: Finding patterns among sets of data which lead to the construction of inferences, predictions, and hypotheses.	K-3	4-6	7-9	10-12
The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:				
1. read information correctly from a graph		ID*	R*	R*
2. determine whether or not a hypothesis can be supported from available data		ID*	R*	R*
3. determine whether or not a hypothesis can be supported from an observable situation		ID*	R*	R*
4. identify the data which apply in seeking answers to investigative questions			ID*	R*
5. define the sets to which objects and events belong according to data collected during investigations			ID*	R*
6. construct data tables for organizing data collected during investigations			ID*	R*
7. identify relationships between variables as outcomes of sorting raw data			ID*	R*
I. INVESTIGATING: Experimenting, manipulating, and testing to determine a result.				
The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:				
1. carry out an investigation		ID*	R*	R*
2. choose problems to investigate when solutions are achievable in regular school laboratories			ID*	R*
3. identify testable hypotheses based on the results of investigation			ID*	R*
4. identify the component parts of scientific investigations			ID*	R*

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J. CONTROLLING VARIABLES:

Identifying the variables of a system and selecting from the variables those which are to be held constant and those which are to be manipulated in order to carry out a proposed investigation.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. identify those variables which should be held constant and the variable that should be manipulated to test the hypotheses		ID*	R*	R*
2. identify those variables which should be held constant and the one which should be manipulated to test a given hypothesis		ID*	R*	R*
3. identify variables which are inferrable from descriptions or observations of natural and contrived phenomena			ID*	R*
4. distinguish between variables which can be manipulated and those which cannot			ID*	R*
5. identify the variable(s) that should be held constant during the course of an investigation			ID*	R*
6. examine the data collected in an investigation and select the sets of data which appear to be related			ID*	R*

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K. FORMULATING HYPOTHESIS:

Construction generalizations that include all objects or events of the same class. Questions, inferences and predictions can lead to the formation of a hypothesis. The hypothesis must be tested if its credibility is to be established.

The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. develop a hypothesis to account for an observation		ID*	R*	R*
2. construct generalizations from sets of data			ID*	R*
3. distinguish between hypotheses and statements which are not useful as hypotheses			ID*	R*
4. identify data which support stated hypotheses			ID*	R*
5. distinguish between inferences and hypotheses			ID*	R*
6. identify or design tests of hypotheses			ID*	R*
7. formulate (identify) revised hypotheses which fit new data			ID*	R*

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	K-3	4-6	7-9	10-12
L. OPERATIONAL DEFINITIONS: Defining objects in the context of a common experience, giving either a description of a function of the object or telling one what to do to the object and what to observe as a result of the action.				
The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:				
1. describe a concrete experience which explains a term		ID*	R*	R*
2. describe changes which occur during an event		ID*	R*	R*
3. describe what an object does or how it is used		ID*	R*	R*
4. identify physical and/or biological entities in an investigation for which operational definitions would be necessary			ID*	R*
5. contrast an operational definition with a non-operational definition			ID*	R*
6. construct operational definitions of physical and biological entities and phenomena			ID*	R*
7. use operational definitions to identify physical and biological entities and phenomena			ID*	R*
M. FORMULATING AND USING MODELS: Describing or constructing, physical, verbal or mathematical explanations of systems and phenomena which cannot be observed directly. Models may be used in predicting outcomes of planned investigations.				
The learner will gain understandings of the following process objectives through selected activities that are consistent with student's intellectual level:				
1. identify similarities and differences in the models of two systems		ID*	R*	R*
2. make predictions from physical and mathematical models			ID*	R*
3. identify or construct diagrams to show relationships among interacting system components			ID*	R*
4. construct physical structures which are analogous of natural phenomena			ID*	R*

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SCIENCE, TECHNOLOGY, AND SOCIETY CATEGORIES

V. Science, Technology, and Society

A. The Relationship of Science and Technology

B. Technology as a System

C. Nature of Technology

D. Science/Technology/Society Problems and Solutions

E. Society/Technology Interactions

V. SCIENCE, TECHNOLOGY, AND SOCIETY (STS)

A. The Relationship of Science and Technology

The learner will gain understandings of the following science, technology and society objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. difference between science and technology		I	D*	DR*
2. science is a basic search for understanding about the natural world		I	D*	DR*
3. technology may involve using scientific knowledge to develop products and/or processes		I	D*	DR*
4. all people interact with technology in many ways		I	D*	DR*

B. Technology as a System

The learner will gain understandings of the following science, technology, and society objectives through selected activities that are consistent with student's intellectual level:

1. complex technology consists of the combination of more simple technologies (automobile manufacturing, food production and distribution)		I	D*	DR*
2. a technological system may include input, processing, output, and feedback		I	DR*	DR*
3. many technologies are interdependent		I	D*	DR*

C. Nature of Technology

The learner will gain understandings of the following science, technology, and society objectives through selected activities that are consistent with student's intellectual level:

1. technology extends the capabilities of human beings (bicycle, refrigerator, microscope)		I	DR*	DR*
2. technology has both capabilities and limitations		I	D*	DR*
3. technology has both advantages and disadvantages (increased productivity, decreased resource availability, and pollution)		I	D*	DR*
4. present technology is influenced by past technology		I	D*	DR*

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D. Science/Technology/Society Problems and Solutions

The learner will gain understandings of the following science, technology, and society objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
1. technology is developed in response to society's needs	I	D*	R*	R*
2. that some technologies may not be developed because of the attitudes of society (nuclear power plants, genetic engineering, compost toilets)		I	D*	DR*
3. short term technological solutions to problems may result in long term detrimental consequences (Agent Orange, deforestation, insecticides, low grade coal's use and acid rain, fertilizers and eutrophication)	I	D*	R*	DR*
4. there may be multiple solutions to complex technological problems (wood, coal, and nuclear sources for the energy problem)		I*	DR*	DR*
5. technology is related to both science and social science. Solutions of societal/technological problems require a multi-disciplinary approach (the economic, political, social, and ecological considerations of solid waste management, food distribution, new medicines)		I	D*	DR*
6. experts and decision makers often disagree on solutions to complex technological problems (nuclear energy, military devices)		I	D*	DR*
7. science and technology cannot solve all problems (health issues, taxes, crime, war)		I	D*	DR*

E. Society/Technology Interactions

The learner will gain understandings of the following science, technology, and society objectives through selected activities that are consistent with student's intellectual level:

1. technology affects society by creating new jobs, modifying present jobs, and making some jobs obsolete		I	D*	R*

I = Introduce
D = Develop
R = Reinforce
* = Level Tested

SCIENCE ATTITUDE CATEGORIES

VI. Science Attitudes

A. Longing to Know and Understand

B. Questioning of All Things

C. Search for Data and Their Meaning

D. Demand for Verification

E. Respect for Logic

F. Consideration of Premises and Consequences

G. Respect for the Order and Beauty of Nature

H. Demonstration of Confidence and Satisfaction

I. Values the Scientific Heritage

VI. SCIENCE ATTITUDES

The learner will gain understandings of the following objectives through selected activities that are consistent with student's intellectual level:	K-3	4-6	7-9	10-12
A. Longing to know and understand provides the motiviation for learning about the universe and its contents	I	D*	R*	R*
B. Questioning of all things exhibits disciplined curiosity with objectivity and open mindedness		I	D*	R*
C. Search for data and their meaning seeks plausible and testable hypothesis which will interpret findings		I	D*	R*
D. Demand for verification requires an empirical test as the basis for judging hypotheses	I	D*	R*	R*
E. Respect for logic applies this valuable method for testing inferences and predictions		I	D*	R*
F. Consideration of premises and consequences conscious of the implications and outcome of definite beliefs and actions		I	D*	R*
G. Respect for the order and beauty of nature recognizes the inter-relationships among all objects and beings	I	D*	R*	R*
H. Demonstration of confidence and satisfaction acknowledges own achievements, capabilities and limitations	I	D*	R*	R*
I. Values the scientific heritage builds on the accumulated knowledge and understanding		I	D*	R*

I = Introduce
D = Develop
R = Reinforce
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NATURE OF SCIENCE

VII. Nature of Science

A. Tentative

B. Replicable and Universal

C. Empirical

D. Humanistic

E. Limited

F. Probabilistic

G. Imaginative

H. Conceptual

I. Holistic

J. Imperative

VII. NATURE OF SCIENCE

The learner will gain understandings of the following objectives through selected activities that are consistent with student's intellectual level:

	K-3	4-6	7-9	10-12
A. TENTATIVE: Scientific knowledge at any point in time is open-ended, not final or absolute. As scientific information accumulates and fresh evidence throws new light on previously explained phenomena, explanations of concepts are revised.	I	D*	R*	R*
B. REPLICABLE AND UNIVERSAL: The knowledge gained in science is based on evidence which, at least in principle, can be repeatedly demonstrated in various places at different times.	I	D*	R*	R*
C. EMPIRICAL: Scientific knowledge gained in science is based on experimentation. Quantitative measurements and sense perceptions leading to empirical data are the foundation blocks on which science is constructed.	I	D*	R*	R*
D. HUMANISTIC: Science is a product produced by, and a process experienced by, human feelings. It is an activity motivated by people seeking to find patterns in, and explanations of, natural phenomena.	I	D*	R*	R*
E. LIMITED: The domain of science is limited to the natural world or universe — basically to the study of matter and energy.	I	D*	R*	R*
F. PROBABILISTIC: Science permits uncertainty principles and probable deduction rather than absolute certainties, particularly when explanations, predictions and extrapolations are applied to natural phenomena.	I	D*	R*	R*
G. IMAGINATIVE: Much of science deals with hypotheses, theories, models, and idealized situations.	I	D*	R*	R*
H. CONCEPTUAL: The nature of science is such that it develops key concepts or conceptual networks which become governing principles within the sbuject itself.	I	D*	R*	R*
I. HOLISTIC: Science deals with a great variety of areas such as biology, chemistry, physics, environmental science, geology, astronomy, and earth science. It relates to technology, geography, family studies, computer studies, engineering, medicine, forestry, agriculture, mining, and a host of other fields.	I	D*	R*	R*

I = Introduce
D = Develop
R = Reinforce
* = Level Tested

J. IMPERATIVE: The nature of science is such that it demands reaction. Science education must underline the point that science calls for decision making.

K-3	4-6	7-9	10-12
I	D*	R*	R*

I = Introduce
D = Develop
R = Reinforce
* = Level Tested

APPENDICES

APPENDIX A

SUPPLEMENTARY RESOURCES

National Science Teachers

NSTA Directory of Science Education Suppliers
1742 Connecticut Avenue N.W.
Washington, D. C. 20009

NSTA Publication List (List of publications by NSTA)
1742 Connecticut Avenue N.W.
Washington, D.C. 20009

Michigan Science Teacher Organizations

Michigan Science Teacher Association
3047 Wellington
Kalamazoo, MI 49008

Michigan Biology Teachers Newsletter
Edite B. Walter, Editor
Kellogg Community College
Battle Creek, MI 49016

Metropolitan Detroit Science Teachers Association
Room 932 SCB
5057 Woodward Avenue
Detroit, MI 48202

Michigan Earth Science Teachers Association
K. R. Cranson, Treasurer
226 Iris Street
Lansing, MI 48917

Michigan Environmental Education Association
414 Chesley
Lansing, MI 48917

JOURNALS AND NEWSLETTERS

AMERICAN BIOLOGY TEACHER
National Association of Biology Teachers
11250 Roger Bacon Drive
Reston, VA 22090

ASTRONOMY
AstroMedia Corp.
625 E. St. Paul Avenue
P.O. Box 92788
Milwaukee, WI 53202

COUNCIL FOR ELEMENTARY SCIENCE INTERNATIONAL NEWS
CESI Membership Chairman
Dr. Betty Burchett
107A Education Building
University of Missouri
Columbus, MO 65211

THE EARTH SCIENTIST
National Earth Science Teachers Association
c/o Dept. of Geological Science
Michigan State University
East Lansing, MI 48824

JOURNAL OF CHEMICAL EDUCATION
Circulation Service
119 W. 24th Street, 4th Floor
New York, N.Y. 10011

JOURNAL OF ENVIRONMENTAL EDUCATION
Heldref Publications
4000 Albemarie Street, N.W.
Washington, D. C. 20016

JOURNAL OF GEOLOGICAL EDUCATION
National Association of Geology Teachers
P.O. Box 368
Lawrence, KS 66044

JOURNAL OF RESEARCH IN SCIENCE TEACHING
National Association for Research in Science Teaching
John Wiley and Sons, Inc.
605 Third Avenue
New York, N.Y. 10016

NATURAL HISTORY
American Museum of Natural History
Central Park West at 79th Street
New York, N.Y. 10024

Journals and Newsletters (Con't)

ODYSSEY
AstroMedia Corp.
625 E. St. Paul Avenue
P.O. Box 92788
Milwaukee, WI 53202

THE PHYSICS TEACHER
American Association of Physics Teacher
Graduate Physics Building
State University of New York
Stony Brook, N.Y. 11794

SCIENCE
American Association for the Advancement of Science
1515 Massachusetts Avenue, N.W.
Washington, D.C. 20005

SCIENCE AND CHILDREN
National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D. C. 20009

THE SCIENCE TEACHER
National Science Teachers Association
1742 Connecticut Avenue, N.W.
Washington, D. C. 20009

SCIENTIFIC AMERICAN
Subscription Department
415 Madison Avenue
New York, N.Y. 10017

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Rosings, Ina, Speigal, and Derek de Solla Price. *Science Technology Society and Science,* Beverly Hills, California: Sage Publications, 1977, p. 374.

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EPC, *Education and the Spirit of Science,* National Education Association 1966.

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— California Science Foundation for the 1980s
— Colorado Science Curriculum Workbook
— National Science Teachers, Recommended Model for Developing a K-12 Science Skills Continuum
— National Assessment of Educational Progress, Science Objectives
— North Carolina Science Competency Based Curriculum K-12

Throughout the 1984-85 school year over 600 draft copies of these essential goals and objectives were reviewed by teachers and supervisors in school districts throughout the state. Copies were also sent to professional teacher and school administrator organizations.

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